DOCUMENT RESUME

ED 268 821 FL 015 661

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TITLE Processing Mathematics in a Second Language: Problems for LEP Children.
PUB DATE Oct 85
NOTE 28p.; Paper presented at the Delaware Symposium VII on Language Studies (Newark, DE, October 24-26, 1985).
PUB TYPE Reports - Descriptive (141) -- Speeches/Conference Papers (150)

EDRS PRICE MF01/PC02 Plus Postage.
DESCRIPTORS *Cognitive Processes; Comprehension; Elementary Education; *English (Second Language); Language of Instruction; Language Proficiency; *Limited English Speaking; *Mathematical Logic; Mathematical Vocabulary; *Mathematics Instruction; *Metacognition; Second Language Learning

ABSTRACT

A discussion of the connections between mathematics, language, and second language acquisition focuses on four major areas: (1) the nature of mathematical performance, (2) the language of mathematics, (3) problems that mathematics poses for limited-English-proficient (LEP) children learning English as a second language, and (4) mathematics as a facilitator of second language development. It is argued that the effectiveness of mathematics instruction for second language development is more complex than making the language input comprehensible, lowering the affective filter, and providing for interactive situations with peers and the teacher. Successful mathematics processing rests at least in part on the ability to use the very precise language of mathematics in mathematical reasoning. The context-reduced language of mathematics, extensive use of logical connectors, specialized vocabulary and syntactic structures, and appropriate discourse rules all present complex problems to (LEP) children engaged in mathematics discourse. These problems seem to be linked to some underlying deep structures in mathematical thinking, a process that is analogous to cognitive/academic language proficiency. If these relationships are understood and addressed in the mathematics classroom, language need not be a barrier to processing mathematics in a second language. (MSE)

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PROCESSING MATHEMATICS IN A SECOND LANGUAGE: PROBLEMS FOR LEP CHILDREN

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Delaware Symposium VII on Language Studies
University of Delaware, Newark, Delaware
October 24-26, 1985

FL 015771

PROCESSING MATHEMATICS IN A SECOND LANGUAGE: PROBLEMS FOR LEP CHILDREN

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When asked what area of the school curriculum other than English as a second language would be most helpful to students of limited English proficiency, nearly two-thirds of a group of 40 teachers answered 'mathematics'. Reasons given were that the first and second language shared mathematics terminology and symbols and did not require as much reading and writing as other content areas. As one teacher expressed, 'language might not be a barrier' or as another put it, 'the student might have a fighting chance at success.'

Perceptions such as these about relationships between mathematics and language are widely held. In spite of research documenting the key role of reading in the ability to solve math problems, attitudes persist that mathematics is relatively 'language free.' As a result, children of limited English proficiency (LEP) are seen as having little difficulty with doing mathematics in English if they have had instruction in their first language (L1).

This paper addresses connections between mathematics, language, and second language acquisition theory. In particular, it focuses on four major areas: (1) the nature of mathematical performance, (2) the language of mathematics, (3) problems that mathematics poses for minority children learning English as a second language (ESL), (4) mathematics as facilitator of second language (L2) development. Examination of these relationships calls into

question the popularly held position about the ease of mathematics for L2 learners.

The position taken here is that the effectiveness of mathematics instruction for L2 development is more complex than making the language input comprehensible, lowering the affective filter, and providing for interactive situations with peers and the teacher (Krashen 1982). Processing mathematics successfully rests, at least in part, on the ability to utilize the very precise language of mathematics in doing mathematical reasoning. The context-reduced language of mathematics, extensive use of logical connectors, specialized vocabulary and syntactic structures, appropriate discourse rules all present a complex set of problems for LEP children engaged in mathematics discourse. These linguistic features serve as links to some of the underlying deep structures utilized in mathematical thinking. The logical reasoning of mathematics draws on an underlying cognitive analytic mathematics proficiency (Dawe 1984a) analogous in certain aspects to cognitive/academic language proficiency (Cummins 1984, 1981).

MATHEMATICAL THINKING AND METACOGNITION

Mathematical thinking may be distinguished from the body of knowledge - content and techniques - traditionally labelled as mathematics. It is a style of thinking that is a function of particular operations, processes, and dynamics connected with the study of mathematics (Burton 1984). Operations on mathematical elements are enumeration or counting, iteration or repetition of a pattern, finding relationships among elements by ordering or

making correspondences, and transforming elements by combination or substitution. The processes of mathematical thinking according to Burton's model include: (1) specializing or examining particular examples, (2) conjecturing about any underlying pattern that may connect mathematical elements, (3) generalizing in recognition of a pattern or regularity, and (4) convincing others as a result of constructing testable arguments. The dynamics propelling mathematical thinking on the cognitive level include manipulating elements such as physical objects, diagrams, ideas, and symbols as well as getting a sense of pattern or relatedness and articulating it verbally or non-verbally. Affectively, mathematical thinking is driven by curiosity, surprise, or the need to resolve a cognitive conflict. The interaction of cognitive and affective experiences is central to the development of mathematical inquiry and learning.

Metacognition also enters into mathematical performance. Garofalo and Lester (1985), building on and refining Polya's (1957) model, distinguish cognition as the doing of mathematics and metacognition as choosing and planning what to do and monitoring what is being done. Thus, both awareness of thinking and regulation of thinking are factors which affect the outcome of cognitive activities.

Flavell (1981) lists person, task, and strategy as major factors or variables in metacognition. What one believes about oneself and others influences mathematical performance. Task variables include information available during a cognitive undertaking.

Knowledge about the scope and requirements of tasks together with the variables that order their difficulty affects outcomes. Metacognitive knowledge about strategies includes both knowledge of strategies and an awareness of their usefulness in carrying out specific tasks. For mathematics this includes knowledge about algorithms and heuristics as well as strategies for helping with problem comprehension, organizing information, planning and executing solutions, and checking results. LEP children who believe that mathematics is very difficult, that they cannot perform well on mathematical tasks, or who are limited to rote strategy usage have metacognitive knowledge that negatively affects mathematical performance. Under such conditions mathematics may inhibit rather than facilitate L2 development.

Flavell (1981) argues that metacognitive knowledge can be activated and used to influence cognitive undertakings even without any conscious awareness of its use. Metacognition influences the decision to use a specific strategy for a specific task. Monitoring cognition involves selecting strategies to aid in understanding a problem, planning a course of action, selecting appropriate strategies to carry out the action, monitoring the results of applying the strategies, and evaluating the outcomes of strategies and plans (Garofalo and Lester 1985). Metacognitive regulatory behaviors are critical for successful mathematical performance, particularly in the complex activity of problem-solving. Problem analysis, strategy selection, monitoring, and evaluation draw on a number of heuristic devices. LEP children who do not utilize metacognitive monitoring skills in mathematical

performance will realize little L2 development from mathematics input.

COGNITIVE ANALYTIC MATHEMATICAL PROFICIENCY AND COGNITIVE/ACADEMIC LANGUAGE PROFICIENCY

To distinguish linguistic demands at school from those in interpersonal contexts outside of school, Cummins (1981) conceptualizes language proficiency along two continuums. One continuum relates to the range of contextual support available to the language user. On the one end, context-embedded communication relies strongly on paralinguistic and situational cues to meaning. This defines basic interpersonal communication skills (BICS) involving face-to-face exchanges. It is, in a certain sense, a surface fluency drawing on concrete situations where 'visible' features of language operate to clarify meaning. On the other end of the continuum, language is primarily context-reduced, relying essentially on linguistic or literacy-related cues to meaning. This is cognitive/academic language proficiency (CALP). The second continuum of Cummins' model addresses the degree of cognitive demands imposed by specific tasks or activities. These range from demanding to undemanding. Utilizing language as an instrument of thought and representing cognitive operations verbally involves both context-reduced and cognitively demanding language use. For purposes here, CALP is used to cover both conditions. Academic success requires this type of language proficiency.

Cummins argues that CALP is cross-lingual. Once acquired, its components are applicable in any language context, L1 or L2, if

enough of the code is available. For LEP children who come to the second language acquisition task with CALP already well developed, L2 realization is highly favored. For those, however, who have little or no L1 CALP, the process is further complicated, as Cummins' (1979) language interdependence hypothesis states.

Acquiring a second language for school use, including mathematics, imposes its own specific tasks. Among them, it requires taking meaning from the printed page without other cues or writing a message in a form from which the reader can get the meaning accurately. Using language as a cognitive instrument in situations where contextual cues are not available imposes heavy demands on LEP children. In addition to the demands of mathematical thinking and awareness of that thinking, the developmental level of CALP in L2 affects mathematical performance. The ability to use context-reduced language as an instrument of thought is vital for success in learning mathematics. Its importance increases with progression through the schooling process.

The two dimensions of language proficiency, BICS and CALP, follow different developmental time-lines. As a result, Cummins (1980) argues that there is a risk period for L2 learners. Recognition of this period, during which use of L2 as an instrument of thought lags behind surface fluency, has important implications for mathematics learning. School settings where children learn mathematics solely through the medium of L2 pose particularly high risks for student failure.

In much the same way that Cummins proposes a model for language proficiency, Dawe (1984a) proposes a model for mathematical proficiency. He distinguishes surface fluency in basic individual mathematical skills (BIMS) from cognitive, analytic, mathematical proficiency (CAMP). Independent of any specific natural language, CAMP is the ability to reason efficiently with the abstract deep structures of mathematics. Like CALP, CAMP is a common underlying proficiency that, once developed, can be channeled through any language available to the user. Much in CAMP, however, is not accessible to verbal retrieval. Verbal-analytic, symbolic, rational thought related to left brain processes and non-verbal, analogic, visuo-spatial, intuitive, non-rational thought related to right brain processes are complimentary thought forms. Development of CAMP accelerates as language becomes increasingly important as a tool for thought during the schooling process. While it shares some of the functions of CALP, CAMP has its own identity, particularly as it draws on right-brain functions.

In a study conducted in England with groups of Punjabi, Mirpuri, Italian, and Jamaican children bilingual in their home languages and English and a group of monolingual English-speaking peers, ages 11 to 14, Dawe (1983, 1985) found that the development of mathematical reasoning in bilingual children is, in part at least, a function of CALP proficiency in L1 and L2. Bilingual children with high cognitive competence, including literacy, in both languages generally outperformed monolingual English peers and other bilinguals in mathematical reasoning ability. Bilingual children with low cognitive competence in both languages performed

the poorest. The major factor on which English monolinguals demonstrated superiority over bilinguals was the ability to use logical connectives in English. Findings indicate an interaction between L1 and L2 such that bilingual children who best preserve L1 are also those who learn to use L2 more efficiently for mathematical thinking purposes. This argues for using L1 as a base until LEP students have acquired sufficient CALP and CAMP to get beyond the risk period when cognitive development in language and mathematics may be seriously impaired.

THE LANGUAGE OF MATHEMATICS

Mathematics uses linguistic features specific to its field of discourse. The meanings belonging to the natural language used in mathematics and the linguistic modifications used in expressing those meanings in mathematical performance define a mathematics register. Dawe (1984b) points out that a mathematics register does not consist solely of terminology. It includes lexical items with special meanings in the context of mathematics such as group or set, expressions with specific meanings such as if and only if and terms borrowed from other languages such as pi or theorem.

The language of mathematics relates very closely to CALP. It is in many respects a written, context-reduced language communicated by signs or symbols, formulas and equations intended to be read. Only the most elementary mathematical expressions can be fully communicated orally (Dawe 1984a). Mathematical performance requires integration of the linguistic aspects of symbolism and

notation along with the specific terms associated with mathematical processing. Extracting meaning from mathematical statements and conveying meaning in spoken or written discourse by appropriate use of the mathematics register poses particular problems for LEP children. Linguistic problems fall under three major categories: (1) vocabulary, (2) syntax, (3) discourse (text). In this section we examine each category, using examples from classroom data for LEP children at various grade levels for whom Spanish is the L1, English the L2.

Vocabulary

In a study of factors affecting academic achievement in a second language, Saville-Troike (1984) found that knowledge of vocabulary is the most important aspect of L2 competence when learning academic content through that language. Lexical knowledge is more important than knowing English morphology and syntactic structures. Information processing in mathematics is closely tied to specialized vocabulary in terms of both specific terms unique to mathematics and lexical items marked with unique meanings for the mathematics register.

Problems with specific terms for measurement are seen in a second-grader's response to multiple choice items asking for names of units used in measuring the length of the day and a quantity of milk. Responding incorrectly with inches rather than hours and pounds rather than quarts may reflect language problems.

A special feature of the mathematics register is the meaning attached to mathematical symbols. Learning the labels for mathematical notions presents its own set of difficulties. A LEP child in grade 4, for example, when asked to circle appropriate symbols for a set of terms, indicated a multiplication product by circling the = sign in the mathematical statement 6 x 7 = 42. Another circled 21 as the quotient in 21 ÷ 3 = 7 and 4 as the dividend in 20 ÷ 4 = 5.

A discourse interaction between an ESL teacher and an older learner illustrates problems with the term quotient:

Student: What's this q-u-o-t-i-e-n-t-? (spelling the word)

Teacher: Math term for an answer in division.

Student: Thought I knew what to do, but when I saw that quotient, I just stopped. Guess I ran out of English.

Another source of vocabulary errors is in the unique meanings that lexical items manifest in a mathematics context. To illustrate, a LEP child in grade 3 was given the directions: Make a table (as used in mathematics). The child interpreted the directions by drawing a picture of a table as used in the home.

Mathematics terms may also be resistant to acquisition. Difficulties in acquiring the unique mathematical meaning for the term subtract are evident in the following exchange:

Teacher: Subtract...

Student: Oh...take away?

Teacher: Yes.

Student: (carries out the computation as required)

Even after 12 weeks of instruction, this student continued to question the teacher, checking the meaning of subtract as take away.

Collocations of words to express mathematical notions is another vocabulary feature in the mathematics register. An example from a LEP child in grade 2 illustrates problems with placing numbers in order. Asked to identify a group of numbers ordered from least to greatest in a multiple choice test item, the child selected the set 86, 58, 87 rather than the correct item 41, 59, 84. Errors also appeared in selecting groups of numbers placed in order from greatest to least as seen in choosing the set 61, 91, 71 rather than 50, 48, 15. Mathematical performance may have been affected by failure to understand the meanings of the expressions least to greatest and greatest to least.

Lexical knowledge, Richards (1985) proposes, involves a complex set of assumptions. Among other points that he makes, word knowledge implies knowing the constraints of function and situation on word choice. Table and subtract, for example, have specific meanings in mathematics discourse. Word knowledge also includes knowing the network of associations between a word and others in the language. The association in mathematics between product and multiplication is an illustration. Knowing a word

also involves knowledge of the base form and the derivations that can be made from it. Being able to relate divide, division, divisor, dividend exemplifies this knowledge.

Knowledge of the specialized vocabulary required for mathematical performance in L2 involves a highly complex set of items and relationships. Lexical competence is crucial for integrating linguistic and mathematical reasoning at underlying conceptual levels. In large measure, vocabulary specifies the conceptual notions of mathematics.

Syntax

Syntax poses two major sources of difficulty for LEP children: (1) the lack of a one-to-one correspondence between symbol conventions and the words they represent, (2) the extensive use of logical connectors linking propositions.

Children tend to read and write mathematical sentences in a manner analogous to reading and writing sentences in standard orthography. In the phrase two deer in the brush, the number qualifier is placed immediately before the noun. In a mathematical context, if r is the number of deer, 2r does not mean two deer.

The problem of word-symbol correspondence is further compounded for children coming from an L1 background with a reading orientation different from that of left-to-right. The right-to-left orientation of Arabic or the top-down of Chinese presents difficulties for LEP children from those backgrounds.

Variation in writing numerals and in the conventions for using the comma and period to signal powers of a thousand or in marking decimal points also affects word-symbol correspondences.

Conventions for reading and writing numbers differ with educational systems around the world. Secada (1983) illustrates how algorithms for subtraction and division can follow a sequence of steps, employ number skills, and have underlying thought processes different from those typically taught in the United States. LEP children who have learned to approach basic arithmetic computations in ways qualitatively different from English-speaking peers may run the risk of being misinterpreted. With different ways of writing a solution process, using different algorithms with different thought processes, divergence can be considerable. Subtraction, for example, can emphasize different aspects of meaning. One apprcach focuses on the take away meaning, another on the addition meaning by supplying missing addends. The equal addition algorithm is a mixture of two meanings: take away and addition. Still another algorithm uses negative number meanings. As Secada points out, these algorithms represent qualitatively different understandings of the subtraction process and can be a potential source of misunderstanding in the L2 classroom.

Errors in word-symbol correspondence are readily apparent in LEP children's verbalization of mathematical statements. A fourth-grader, for example, wrote <u>two add two seem four</u> for the mathematical expression 2 + 2 = 4. This student clearly understood the meaning but had difficulty articulating it in

English syntax. In another grade 4 class, 16 LEP children were asked to verbalize in writing the mathematical expression:

$$3\overline{)9}$$

Of the 16 children, 15 wrote three divide(d) by nine equal(s) three. However, they had no problem articulating accurately the same division problem written mathematically as $15 \div 3 = 5$.

Within a mathematics text abstract ideas are logically developed and linked with one another through a number of linguistic devices. These include use of logical connectors such as and, or, if...then, because, for example, but, consequently, however, either...or. Logical connectors are words or phrases which function to mark a logical relationship between two or more basic linguistic structures. Primarily, logical connectors serve a semantic, cohesive function, indicating the nature of the relationship between the parts of a text. In terms of register, this includes being aware of the formal connector in contrast to the informal connector and the situations appropriate for both. Mathematics texts typically include connectors which signal addition or similarity, contradiction, cause/effect or reason/result, and chronological or logical sequence (Celce-Murcia and Larsen-Freeman 1983). The syntax of logical connectors involves knowing where in the sentence they should occur - clause initial, medial, or final. Certain connectors are restricted to a specific position while others occur in all three. Change in the syntactic position of logical connectors can result in changes in meaning. Subtle semantic differences can be seen in an

expression such as (1) Even though Maria went on a diet, she continued to gain weight and (2) Maria continued to gain weight even though she went on a diet. In sentence (1) the meaning is counter-to-expectation. In contrast, sentence (2) continues the train of thought from the previous context.

Logical connectors pose problems for LEP students at all levels. In an example at the kindergarten level, if...then problems appear in tasks that ask children to look at a set of 3 yellow ducks and 3 pink rabbits in order to respond to the statement If it's pink, it's a _____. or If it's yellow, it's a _____. In a class of LEP children, the error rate was 50%. This suggests that the major strategy used for solving this task was guessing.

In a study contrasting the use of logical connectors by LEP children at grade 6 with those at grade 8, Tritch (1984) found that sixth-graders categorically had more problems with logical connectors than eighth-graders. This indicates a developmental sequence for logical connectors that L2 learners may typically follow. Research evidence (Dawe 1983) indicates that logical connectors play a vital role in the development of the ability to reason mathematically in ESL.

Discourse (Text)

When a class of grade 4 LEP children was asked to carry out a mathematical computation using symbols only, the class as a whole scored 51% accuracy. However, when the same problem was presented

as a word problem requiring exactly the same computations, the accuracy level was only 6%.

The ability to solve word problems requires understanding linguistic and mathematical meaning along with planning solution strategies. This draws on both cognitive and metacognitive functioning. Learning how to think and becoming aware that certain actions are likely to work better than others tap metacognitive behaviors. LEP students who do not have adequate linguistic development in L2 to interact with cognitive and metacognitive processes experience serious difficulties in solving word problems. For example, grade 2 LEP children were given the following problem: <u>There are 30 carrot plants in 6 rows. If there are the same number of plants in each row, how many plants are there per row?</u> A typical response showed the following computation:

$$\begin{array}{r} 30 \\ \times\ 6 \\ \hline 180 \end{array}$$

These children failed to interpret the problem correctly and to realize that the mathematical operation involved was division.

Reading comprehension is an integral part of solving word problems, a competency that overlaps with both CALP and CAMP. Word problems exemplify the context-reduced language of mathematics with its characteristicfor lack of redundancy or paraphrase. Furthermore, word problems also reach into the real world context in which language is used for mathematical thinking. As a result, they are often culture-bound. In terms of language, they present

problems that go beyond competence in linguistic form to those components of communicative competence which Canale (1983) defines as sociolinguistic competence and discourse competence.

Discourse competence in mathematical reasoning involves, among other aspects, the ability to carry out specific language functions in the context of mathematics. In Searle's (1976) taxonomy, functions extensively used in mathematics are representatives or telling how things are, and directives or requesting others to do things. Word problems use the representative and directive functions of language extensively. LEP children very typically have difficulty with these functions in problem-solving contexts. Grade 2 LEP children, for example, could not interpret the problem: Sue has 32 cards. She gave Jim 15 cards. How many cards did Sue have? Many answered 15 rather than 17. Failure to solve the problem correctly may, in part, be attributed to not recognizing the representative function expressed in having 32 cards and giving 15 of them away or in the directive function requesting students to give the number of cards remaining. In either case, they missed the conceptual notion of subtraction.

Solving word problems makes use of language for thinking purposes in a real world context. It requires integration of complex linguistic and mathematical processing. CALP and CAMP, cognitive functioning and metacognitive behaviors interact in ways as yet little understood in the mathematical performance of L2 learners.

The language of mathematics is complex and much remains to be analyzed in its relationship to the linguistic needs of the ESL student. As Cuevas (1984) points out, the dearth of research on the relationship between language and mathematics learning becomes almost a void when attention is directed to LEP children's performance in a second language.

LANGUAGE ACQUISITION IN MATHEMATICS CONTEXTS

Second language acquisition is a socio-cognitive process resulting from efforts to participate in communicative interactions. As the exchange and negotiation of conceptual, sociocultural, and affective content, mathematics provides a form of social and cognitive interaction that meets requirements for genuine language use. Mathematics provides a context in which L2 acquisition can occur.

Current L2 acquisition theory assigns a critical role for the successful development of ESL to the school content areas. Defining language acquisition as a natural, subconscious process that takes place when the focus is on communication or meaning, Krashen (1982) argues that this process is central to L2 development. Causative variables are the amount and quality of comprehensible input that the student receives and the set of affective variables that alter the learner's openness to language input.

When taught in ways that utilize visuo-spatial imagery, concrete objects, and other devices to clarify meaning, mathematics can

provide a source of meaningful, relevant input. Hands-on, concrete experiences such as used in taking measurements or in working with shapes contribute to understanding meanings. So too do graphs, charts, diagrams. The quantity and quality of the input available and the extent to which each child can make use of it affect L2 acquisition outcomes. The school's way of structuring the input and the child's own set of characteristics brought to the L2 task interact to facilitate or inhibit the process.

With effective instruction, mathematics can contribute to establishing the necessary affective conditions that facilitate language development. Just as the interaction of cognitive and affective experiences is central to the development of mathematical inquiry and learning so is it to the development of L2. The curiosity, surprise, or need to resolve a cognitive conflict that affectively drives mathematical thinking also drives language acquisition. In mathematics instruction, the teacher can tap the student's prior knowledge of the subject, build on it, and at the same time lead the student to a realization of that knowledge in a new language system. Affective variables may exert stronger effects with increasing age and maturity. In addition to the affective climate set in the classroom by the teacher, the learner's attitudes towards the new language and culture and the content area of mathematics can interact positively or negatively. Success depends in large measure on the teacher's own sensitivity to each child's level of language and mathematics proficiency and knowing how to make the modifications necessary to insure comprehensible input.

Acquisition of the sociolinguistic rules for using the mathematics register appropriately takes place over an extended period of time. Development of the necessary language forms to carry out specific functions in a variety of ways and an awareness of the socio-mathematical significance of specific forms is a complex process closely paralleling cognitive growth and increased proficiency in the L2 system (Kessler 1984).

The classroom structure with its instructional style and student composition is a variable which can inhibit or promote L2 acquisition. Mathematics instruction which provides alternate ways for getting input through small group work and peer tutor interactions can contribute, under appropriate conditions, to language development. Interaction in heterogeneous groups in which students learn to use one another as resources regardless of linguistic differences facilitates conceptual learning for all students. De Avila (1983) has shown that under classroom organizational conditions where LEP students are provided with access to interactive settings, students can acquire both mathematics and English simultaneously. Evidence for the concurrent development of math/science and ESL comes from a number of studies in both bilingual and monolingual English settings (Quinn & Kessler, in press; Kessler & Quinn 1980; Rodriquez & Bethel 1983).

Literacy is crucial to the development of mathematical reasoning.

For LEP children lacking reading and writing skills, experience in writing and solving their own mathematics problems can contribute to successful language acquisition and mathematical performance.

In a class of 22 bilingual Spanish/English migrant children in rural South Texas, Larry entered fifth grade functionally illiterate in English. So did most of his classmates. After extensive experiences in writing - dialogue journals, class publications, among other activities - and participation in a classroom in which a sensitive teacher set a very positive affective climate, Larry quite literally wrote his way to reading. The other LEP children did too. (Hayes & Bahruth 1985; Hayes, Bahruth & Kessler 1985). Success in large measure resulted from affective changes in attitudes about school and learning and from great quantities of language input provided through teacher and peer interactions in contexts that made reading and writing interesting and relevant. By the end of March that year, Larry, who could hardly read or write in September, wrote the following word problem:

> Jaime went to the store
> Jaime had $7.30 and he bought a six pack of beer for Mr. B it cost $3.00 and a magnifying glass for $2.50 and a bag of chips for 50 c. How much did he spend? $6.00. How much did he have left? $1.30

In addition to the necessary computations, this paper also includes a drawing of Jaime's going to the local supermarket. Mathematics had connection to Larry's world. It made sense and become a subject of interest, along with the rewards of learning to read and write. Larry's successful development of literacy and mathematical performance in English, his second language,

illustrates in a very basic, concrete way the interrelation of language and mathematics.

Meaningful, relevant input provided in a supportive, low anxiety setting with extensive opportunities to interact with others can lead to second language acquisition. However, the specific demands of cognitive/academic language proficiency in the context of the mathematics register and the specific demands of cognitive analytic mathematical proficiency must be recognized for the complexities they present in the school setting. Furthermore, the effect of metacognitive knowledge and regulatory behavior on mathematical thinking and the processing of mathematical information must enter into any assessment of the role that mathematical input plays in facilitating L2 development. Language need not be a barrier to processing mathematics in a second language if the complexities of the relationship are recognized and addressed.

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